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PROCEEDINGS

Triply Periodic Minimal Surface and Constant Mean Curvature Surfaces Formed Rib Structure's Energy Absorption

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ABSTRACT

This paper explores the design and fabrication of ultralight, rib-strengthened mechanical metamaterials, specifically focusing on thin-walled lattice structure and rib-formed lattice structure in micro 3D printing. The lattice structures, based on triply periodic minimal surfaces (TPMS) and constant mean curvature surfaces (CMCS), provide large surface areas and continuous internal channels with lightweight and multifunctional structural applications. Algorithm designed in this paper incorporates a dynamics relaxation solver to generate pure TPMS and ribbed CMCS, enhancing the lattice design of metamaterials and the use of parametric modeling facilitates the creation of metamaterial lattice models. The paper delves into the theoretical foundations of dynamic relaxation and quasi-isothermal theories, showcasing a workflow divided into four parts: generation of TPMS and CMCS, isothermalization of TPMS and CMCS, generation of asymptotic curve of minimal surfaces, and rib generation. The dynamic relaxation method and quasi-isothermal theory contribute to the process, aiming to create high-quality lattice structures with specific features.

The Finite Element Analysis (FEA) results demonstrate the high potential of the asymptotic-rib structures in energy absorption compared to shell structures with the same volume. These results contribute valuable insights into the superior mechanical properties of the lattice structures, supporting their viability for use in various engineering and structural applications.

KEYWORDS

Asymptotic; TPMS; thin-walled structure; rib

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